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Investigation of maximum torque values in manual tightening of dental implant healing screws

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ABSTRACT

Aims: This study aimed to investigate the change of the maximum torque values applied by the dentist according to the parameters of gender,dental experience and glove type used in the tightening processes applied manually by pre-graduated and post-graduated dentists to the implant superstructure parts.

Methods: 24 dentists (11 Male, 13 Female) participated in our study.Participants were instructed to tighten the implant healing screw (Straumann Dental Implant System, Waldenberg, Switzerland) placed on the digital torque measuring device(Cap torque tester series TT01; Mark10, Copiague, NY)by applying maximum force with a manual wrench.Powdered latex gloves,powder-free latex gloves and sterile surgical gloves were made available to the participants in order to imitate the mouth conditions as much as possible.Manual tightening was repeated three times in each group,with at least three minutes duration.Data were recorded digitally and statistical analysis was performed with IBS SPSS statistics 22 program.Independent sample t-test and one-way Anova analysis were used to evaluate differences between groups,followed by the post-hoc Tukey test.

Results: Maximum torque value for tightening with powdered latex gloves (20.01±5.55) N, powder free latex gloves (17.27± 4.34) N and surgical gloves (20.27±6.02) N was found.In addition, we did not find a statistically significant difference in terms of gender and dental experience,which are the other parameters we investigated.

Conclusion: Gender, experience and glove type do not statistically affect the maximum torque to be applied in implant superstructure applications.

Keywords: Manual torque, Dental experience, Latex glove

This study was presented as an oral presentation at the 26th Turkish Dental Association International Dentistry Congress September 8-11, 2022.

INTRODUCTION

Dental implant is an osseointegrated prosthetic appliance that supports removable or fixed, partial or full dentures placed in the maxilla and/or mandible in cases of partial tooth deficiency or total edentulism.[1] Torque force means the turning force applied to an object. It is used when placing the dental implant in the jaw. Dentists may prefer various methods when tightening implant superstructure parts. Torque with manual wrenches and torque with ratchets are among these methods. Torque with ratchet is known to cause less screw loosening problems than torque with manual wrenches.[2-4]

After the dental implant is osseointegrated, healing caps are used to shape the soft tissue. The connection of the healing caps and other superstructure parts to the root part of the implant should be done with optimum torque. Screwing and tightening with proper torque is a very important factor for implant survival. Undertightening causes problems such as screw loosening, over-tightening exceeds the yield strength of the screw and may cause permanent deformation, loss of mechanical properties, and screw fractures. Dentists should have an idea of the amount of force they exert when using manual wrenches to torque implant suprastructure parts. Implant manufacturers usually give the average torque force required for implant placement and abutment screw between 20-32 N/cm², but do not specify average force for parts such as impression posts and healing cap.[6] There are no known studies on the torquing of the dental implant healing cap. In this study, we aim to determine how well the implant manufacturers recommended torque values matched with dentists gender, application method and experience.

METHODS

This study does not contain any human or animal materials. It is an in vitro study under laboratory conditions. Therefore, it does not require an ethics committee approval. Institutional approval has been obtained. All procedures were carried out in accordance with the ethical rules and the principles.

Twenty-four dentists (11 male, 13 female) participated in our study. Participants consist of 12 post-graduated dentists and 12 pre-graduated dentists. The post-graduated dentists were selected from the departments of prosthetic dentistry, oral and maxillofacial surgery

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and periodontology, which have the opportunity to work with implant superstructures. In our study, there are three groups which separate each other with glove type. There are three types of gloves, Group 1 which is used powdered latex gloves (Valeriai, Turkey), Group 2 is used powder free latex gloves (Valeria, Turkey) and Group 3 is used surgical sterile gloves (Beybi Gold Plus, Malesia).

A setup was prepared with an implant screw embedded in cold acrylic to manually torque the healing cap (**Figure 1**).

Participants were instructed to tighten the healing cap with manual hand wrenches with maximum torque on the implant screw (Straumann Dental Implant System, Waldenberg, Switzerland) placed on a digital torque measurement device (Cap torque tester series TT01; Mark10, Copiague, NY) (**Figure 2**). Since the measurements were made digitally, they were measured and recorded once in each group. Because of digital measurements were not subjective, the application was not repeated.

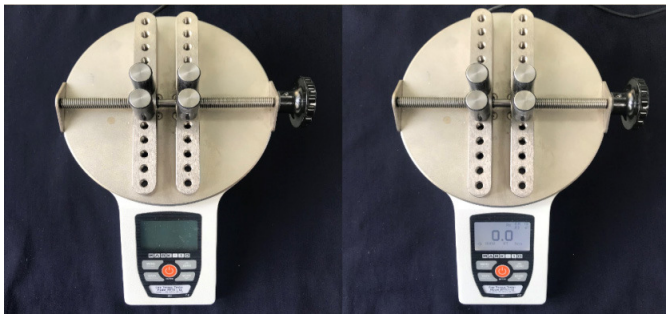

Figure 2. Digital torque measurement device (cap torque tester series TT01, Mark10, Copiague,NY)

Powdered latex, powder-free latex and surgical gloves were used by the participants (**Figure 3**).

Figure 3. There are three types of gloves.

Statistical Analysis

Maximum tightening was repeated three times in each group, with at least three minutes duration. Data were recorded digitally and statistical analysis was performed with IBS SPSS statistics 22 program. Independent sample t-test,one-way Anova analysis, post-hoc Tukey test were used to evaluate differences between groups with gender, glove type and experience parameters. In all analyses, $p<0.05$ was considered statistically significant.

RESULTS

When we investigate the each group, we found that Maximum torque value for Group 1 (20.01±5.55) N, Group 2 (17.27± 4.34) N and Group 3 (20.27±6.02) N was found (**Table 1**).

The maximum force differences between genders, tightening with powdered latex gloves, the maximum torque value is (18.34±4.80) N for women and (21.98± 5.95) N for men; The maximum torque value when tightening with powder-free latex gloves is (15.90±4.27) N for women and (18.89±4.02) N for men. On the other hand, it was found (18.32±5.92) N in women and (22.49±5.60) N in men in tightening with surgical gloves (**Table 2**).

Table 2. Torque application values by gender

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Powdered gloves	Men	13	18.3462	4.80271	1.33203
	Women	11	21.9818	5.95043	1.79412
Powder-free gloves	Man	13	15.9077	4.27365	1.18530
	Women	11	18.8909	4.02006	1.21209
Surgical gloves	Men	13	18.3923	5.92361	1.64291
	Women	11	22.4909	5.60900	1.69118

For dental experience parameters, which have equal participants, for tightening with powdered latex gloves, the maximum torque value was (19.45±4.57) N for post-graduated and (20.57±6.54) N for pregraduated dentists; (17.25±2.54) N for post-graduated and (17.29±5.79) N for pre-graduated dentists with powder-free latex gloves; (19.55± 4.29) N post-graduated and (20.99±7.51) N and pre-graduated dentists with surgical gloves were found (**Table 3**).

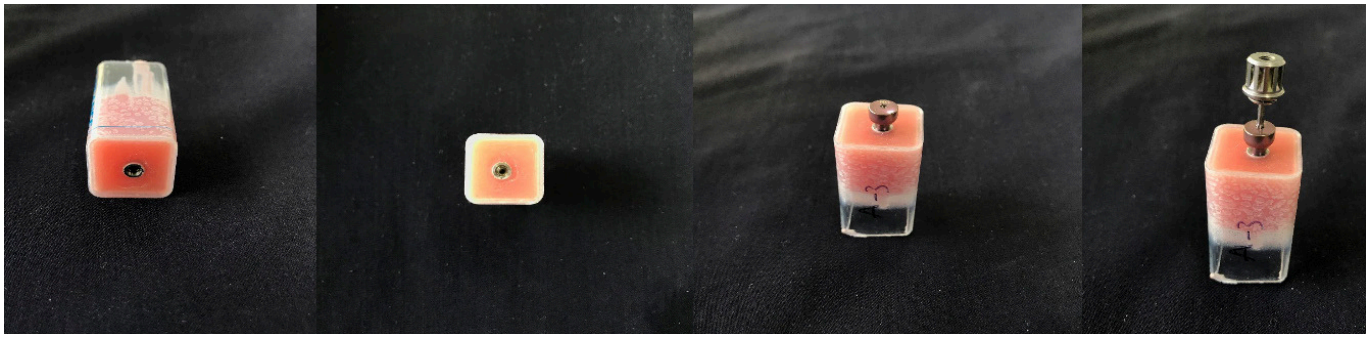

Figure 1. A setup was prepared with an implant screw embedded in cold acyrclic to manually torque the healing cap.

Table 1. Torque application values by glove type

	N	Mean	Std. Deviation	Std. Error	%95 Confidence Interval for Mean		Min.	Maks.
					Lower Bound	Upper Bound		
Powdered gloves	24	20.0125	5.55458	1.13382	17.6670	22.3580	9.90	31.70
Powder-free gloves	24	17.2750	4.34294	0.88650	15.4411	19.1089	8.30	24.70
Surgical gloves	24	20.2708	6.02808	1.23048	17.7254	22.8163	10.60	31.90
Total	72	19.1861	5.45337	0.64269	17.9046	20.4676	8.30	31.90

Table 3. Torque application values by experience

	Experience	N	Mean	Std. deviation	Std. error mean
Powdered gloves	Post-graduated dentists	12	19.4500	4.57612	1.32101
	Pre-graduated dentists	12	20.5750	6.54830	1.89033
Powder-free gloves	Post-graduated dentists	12	17.2583	2.54289	0.73407
	Pre-graduated dentists	12	17.2917	5.74194	1.65756
Surgical gloves	Post-graduated dentists	12	19.5500	4.29323	1.23935
	Pre-graduated dentists	12	20.9917	7.51090	2.16821

The difference between the maximum torque measurements in the studied parameters was not statistically significant (p>0.05).

Table 4. Post-graduated dentist manual torque values - women

	Powdered gloves	Powdered-free gloves	Surgical gloves
1	12	13.9	13.4
2	23	20.2	20.1
3	16.6	14.6	13.5
4	12.4	15	12.4
5	17.6	16.2	21.4
6	25.6	20.6	22.4
7	19.6	18.3	21.2

Table 5. Post-graduated dentist manual torque values - men

	Powdered gloves	Powder-free gloves	Surgical gloves
1	19	17.3	21.7
2	18.3	14.4	17.3
3	24.2	17	24.1
4	19.4	18.3	23.2
5	25.7	21.3	23.9

Table 6. Pre-graduated dentist manual torque values - women

	Powdered gloves	Powdered-free gloves	Surgical gloves
1	24.5	14.2	31.5
2	15	8.3	14.9
3	18.4	23.4	11.3
4	19.5	13.7	23.8
5	23	18.6	20.5
6	11.3	9.8	12.7

Table 7. Pre-graduated dentist manual torque values - men

	Powdered gloves	Powdered-free gloves	Surgical gloves
1	18.4	16.7	18.9
2	28	24	27
3	31.7	20.9	31.9
4	21.2	21.6	22
5	9.9	11.6	10.6
6	26	24.7	26.8

DISCUSSION

Studies on the torque of the dental implant are related to the implant loading and the torque of the abutment screw. There are no known studies on the torquing of the dental implant healing cap. The most common complication in implant-supported prosthetic restorations is loosening of the abutment screw.[6-8]

Previous studies have indicated that the lowest applied force abutment screw preload torque is important. They also showed that excessive torque can exceed the yield strength of the material.[6]

Both Goheen et al.[5] and Hill et al.[11] showed a variable range in torque force reached with manual wrenches among study participants. The study by Goheen et al. tested oral and maxillofacial surgeons and prosthetic dentists working with dental implant parts. The total maximum torque produced with the manual wrenches was 36.2 N/cm². Our study confirms that participants show different degrees of torque values in their applications. In addition; In our study, it was observed that the participants could not reach the maximum torque value of 32 N/cm², which is determined by the implant manufacturers, with manual wrenches.[9] Therefore, dentists should be careful about both the under-torque and over-torque of implant parts. Dental implant manufacturers need to be more precise about the torque values they recommend for all implant superstructure parts.[10]

The in vitro study of Neiburger et al.[12] showed that,likewise in our study, patient-specific intraoral factors such as salivation, mouth opening,lack of vision,and patient cooperation can negatively affect the dentist's manual dexterity. It can be assumed that these factors will have a negative impact on the dentist's ability to grip the manual hand wrench and on his ability to generate preload torque. It has been shown that even the gloves that we use in clinical practice greatly reduce the ability to hold hand tools and the tactile sense.[13]

In their study, Tomoki Nishiuchi et al.[14] had participants torque with and without gloves using manual wrenches. Our study differs from theirs in gender parameters. As a result of their study, it was seen that the torque value created by male participants when wearing gloves was higher. It was observed that the force applied by the female participants was relatively lower than the male participants. If we examine our study, no statistically significant difference was found between the maximum torque values applied by men and women, regardless of whether they were wearing gloves or not.

In the study of Alikhasi et al.[15] it was requested participants to apply maximum force to the abutment screw by using different types of manual wrenches.As a result, it was concluded that the torque strength of male users was higher than that female participants. In our study, unlike to the study of Alikhasi et al.[15] the gender parameter does not affect the torque strength.

Goheen's study[5] examined at the ability of the abutment screw to generate preload torque; based on dental experience in dentistry. It was concluded that the force applied by the oral and maxillofacial surgeons who participated in the study was better than the general dentists,but we did not found any differences in dental experience parameters.

Parnia et al.[16] compared manual wrenches and abutment screw torque strengths of professors and general dentists using a digital torque measuring device. As a result, no statistically significant difference was found between the two groups in the maximum force. Dental experience data, which is one of the parameters examined in our study, also showed parallelism with the results of this study.[15]

Tahir Karaman et al.[17] torqued the abutment screw with manual wrenches using latex and nitrile gloves also investigated gender differences. As a result, it was found that the maximum torque force applied with powdered latex was higher than the nitrile glove. No significant difference was found in the gender parameter. The gender parameter, which is also one of the parameters investigated in our study, did not show a significant difference as in this study.

Altintas et al.[18] They applied manual torque to prefabricated posts using the digital torque measuring device (Cap torque tester series TT01; Mark10, Copiague, NY) like we used in our study.

CONCLUSION

In the manual torque of the healing cap, the maximum torque values were investigated according to different parameters. Gender, which is one of the parameters related to the torque of the dental implant healing cap, did not make a significant difference in the ability to torque the healing cap. Likewise, the type of glove used did not change the ability to generate torque. Dental experience, the last parameter we examined, also did not make a difference in torque. Further work is required for more accurate and reliable results.

ETHICAL DECLARATIONS

Ethics Committee Approval: This study does not contain any human or animal materials. It is an in vitro study under laboratory conditions. Therefore, it does not require an ethics committee approval.

Informed Consent: This study is in vitro study under laboratory conditions. Therefore, it does not require informed consent.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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